



SUSTAINABILITY & CLIMATE ACTION PLAN

April 14, 2022

Sustainability and Climate Action Plan Ad Hoc Committee Meeting Focus: Carbon Neutrality

62 attendees + 10 additional via YouTube Live Stream

Questions and Answers

1. Will the city be engaged in carbon dioxide (CO₂) capture and sequestration in Palo Alto?
 - A. The City's engagement in carbon capture and sequestration and any location that sequestration takes place is a Council policy decision. Discussions are only just beginning on this topic. The primary focus for the S/CAP Committee right now is on programs to reduce emissions. Discussions of carbon capture and sequestration may take place later in 2022.
2. Some Council members talk about Palo Alto's urban *[tree]* canopy, what piece of the carbon pie is this? How does the **current** urban canopy provide needed additionality? Would it need to be expanded to count? *[NOTE: "Additionality" refers to whether emissions reductions or carbon capture and sequestration are above and beyond what would have happened without human intervention].*
 - A. Palo Alto's urban forest currently sequesters an estimated 28,875 - 49,000 metric tons of CO₂ per year, depending on the methodology used. The City's [Urban Forest Master Plan](#) has goals to increase the canopy coverage. This will lead to carbon sequestration as we make progress on those goals.

The City is awaiting guidance on whether the current urban canopy provides additionality. We are unaware of a uniform standard or methodology, so a standard would need to be developed before quantifying the carbon sequestration potential of Palo Alto's urban canopy.

3. In the "What Could Palo Alto Do?" chart *[NOTE: See slide 25 of the [presentation](#)]*, what percentage of the "Current Urban Canopy" is actually in residential areas, as opposed to parks, foothills, and other non-residential areas?
 - A. The City partnered with a Stanford class to study carbon sequestration. The study looked at overall canopy cover (37%) without identifying where the cover was located. A true calculation of the City's carbon sequestration would require a detailed inventory and measurements of all street trees, trees on private property, and trees within parks and preserves in Palo Alto. Such an inventory is likely infeasible due to the cost and labor

constraints that it would entail. However, the Stanford team did note that expanding the urban canopy would likely need to be largely on private property, as the City has already planted an extensive street tree inventory on public property.

4. It would seem that estimates of the cost per metric ton to capture and permanently sequester carbon dioxide could be used to tell us which emissions **reduction** actions should be taken to minimize the cost of hitting climate targets. *[NOTE: by comparing the cost per metric ton of the emissions reduction actions to the cost per metric ton of capturing and sequestering carbon]* Has the City studied this optimization?

- A. In the [Sustainability and Climate Action Plan \(S/CAP\) impact analysis](#) delivered to Council in April 2021, staff gave some initial estimates of the cost per metric ton of various electrification measures. EVs showed a net savings per metric ton, while most single-family building emissions could be reduced for under \$200 per metric ton, in many cases significantly less if done right. Other emissions reductions measures in multi-family and non-residential settings were more costly, but staff's estimates were very preliminary and there is more study to be done in these areas to find the least costly approaches to multi-family and non-residential building electrification, since these will also be critical areas where we can reduce emissions.

Additionally, costs for carbon removal technologies are very uncertain right now, but we intend to continually compare these costs against the costs of emissions reductions as we highlight policy options on how to achieve emissions reductions goals. But it is important to remember that we need to use all of these tools to combat global warming: deep emissions reductions **and** carbon removal. There is likely not enough carbon removal capacity in the world to offset our emissions unless we achieve those deep reductions, regardless of the cost. So it may be more complicated than just comparing costs per metric ton.

5. Does the city need to worry about carbon neutrality when it has already adopted an emissions reduction goal of 80 x 30? Will knowing how we will reduce the last 20% of emissions and when via CCS change our plans or priorities to reduce the first 80% of emissions with reduction measures in 10 years?
 - A. Carbon neutrality is important to think about in the near term because the technologies and projects required to achieve neutrality have a long lead time to implement. But the primary focus of the City's efforts will be on reducing emissions from fossil fuel use. Considering carbon neutrality would not change our priorities with respect to 80x30.

6. If I understood Professor Field correctly, he (a) cited Griscom, B., et al., "Natural climate solutions" (<https://doi.org/10.1073/pnas.1710465114>), and (b) the article to which he cited used a 100 USD cost-effectiveness threshold to reach the higher CO₂ mitigation levels discussed. Q1: Is that correct? Q2: If that is correct, then why is the city not focused considerably more on instituting carbon pricing measures to achieve carbon neutrality based on at least a 100 USD MgCO₂-1 price (which would probably now be higher, given the inflation experienced since the paper was written)?
 - A. A1: That citation sounds correct, though we cannot confirm that with complete confidence. A2: Carbon pricing is one policy option that the City can consider to spur climate action. We are actively discussing which policy options to pursue and welcome feedback like you have provided.

7. What are the milestones for home electrification that we are tracking to meet the 80 x 30 goal? Specifically, of the ~25,000 residences, what are the yearly milestones for heat pump water heater installation and heat pump HVAC system installation for the next 8 years?
 - A. There are over 15,600 single-family detached homes and nearly 12,000 multi-family units. The [April 2021 S/CAP impact analysis](#) listed a number of measures to achieve 80 x 30. The identified measures were only estimated to be enough to achieve 71 x 30, so more emissions reductions need to be identified. But among the measures identified were electrification of all or nearly all single-family homes. The analysis did not find much cost-effective multi-family or non-residential electrification, but more study needs to be done in this area. So to achieve the 80 x 30 goal, most single-family homes would likely need to be electrified by 2030, or alternative electrification of multi-family and non-residential buildings would need to be identified. More likely, electrification of multi-family and non-residential buildings would need to happen alongside single-family home electrification to bridge the gap between 71 x 30 and 80 x 30.

With respect to heat pump water heater and heat pump HVAC systems, there are no publicly tracked metrics yet, but this is an active discussion topic with the S/CAP Climate Committee's Working Group Teams. With a lifetime of around 13 years per water heater, about 1200 of the 15,600 water heaters in single-family homes are likely replaced each year, but that is hard to confirm via building permits because many are replaced without permits. The number is also slightly lower because some homes have tankless water heaters. But assuming all water heaters in Palo Alto were replaced with heat pumps, staff estimates it would save approximately 15,400 MT/year, or approximately 2% of the 80% reductions we are trying to achieve.

8. On reducing carbon emissions, is the city planning on adding additional electrical capacity to support building electrification for commercial buildings?
 - A. Yes, the City is actively working on a grid modernization plan and other measures to ensure the electric grid can accommodate building and vehicle electrification. This is an active topic of discussion with the S/CAP Climate Committee Working Group Teams right now.
9. When can we expect to get an update on home electrification roll out plans?
 - A. We are planning to have an update in September.
10. Since we're talking about options for low-carbon diet, are there also options for low-carbon air transportation? The carbon footprint for a roundtrip between San Francisco and New York City is 1.2 tonnes, equivalent to that of the 40% of the annual emissions for a mixed fuel home.
 - A. There may well be low-carbon air transport options and exciting developments. Staff has not started researching this area yet.
11. Does the City consider green hydrogen a storage technology or an energy source?
 - A. Green hydrogen can be a storage technology or an energy source. In its role as a storage technology green hydrogen enables the use of renewable energy to generate hydrogen that can be used at other times of day to generate electricity. In its role as an energy source green hydrogen can be used in combustion or industrial processes or as a transportation fuel.

12. The definition of carbon neutrality used in the staff presentation [NOTE: defined as “achieving net zero emissions for the community”] is not the same as the City uses on its website [NOTE: when discussing the Carbon Neutral Electric Portfolio and Carbon Neutral Gas Portfolio]. It seems confusing.
- A. We acknowledge that some members of the community have expressed concern about using the words “Carbon Neutrality” for the City’s electric and gas portfolios due to the potential confusion with the IPCC goal of carbon neutrality. As described on the City’s [website](#), “carbon neutrality” for electricity means that we match electricity demand with carbon free supply on an annual basis, taking into account the hourly variation in carbon emissions on the electric grid to ensure we achieve net zero carbon emissions. For natural gas, carbon neutral means that we buy carbon offsets to balance emissions from natural gas use in Palo Alto. It is worth noting that the City decided on the term “carbon neutral” in 2013 for electricity and 2016 for natural gas, well before global carbon neutrality goals were being actively discussed by the State of California and local agencies. But it may be worth re-evaluating the branding in light of the growing use of the words “carbon neutrality” to reflect a global carbon goal rather than an energy-specific goal.

Suggestions from Participants

- I suspect a comparison of the cost of carbon capture and sequestration to the cost of emissions reduction would tell us to immediately pursue all CO₂ reduction paths that cost less than, say, \$200 per ton. (where \$200/ton was the marginal cost per ton to get to the required carbon capture and storage (CCS) level according to the oil companies promoting CCS as economic.)
- Can some improvements be made to the management of local landfill gas leakage to drive it below the thousands of tons per year allowed and happening now? For example, could moving above legal minimums to more frequent monitoring and clay patching of the clay landfill cap and pipe system? Or dynamically adjusting the extraction suction pressure to limit leakage if monitored? If these cost less than carbon capture and sequestration they could be cost-effective emissions reduction.
- It sounds like Dr. Fields says natural CO₂ removal may be able to grow to 1/4 of the amount of CCS that we need and maybe at a cost of \$100/ ton. The other marginal 3/4 of needed CCS will happen at presumable higher prices. This tells me there is lots of economic room for CO₂e Emission Reduction at under the optimistic CCS marginal cost of \$200/ton removed.
- EVs are VERY ecologically expensive. There is no free lunch. The upstream costs to build the battery alone includes mining of rare minerals with concomitant damage to countries outside the US. And if recharging requires burning coal / gas to produce electricity, those costs must be considered.
- Cost per tonne is not the only measurement. Emissions reductions has multiple side benefits, greater quality of life, health, employment, etc.
- I love the urban canopy as an amenity. It has so many co-benefits to society and local wildlife. But I don’t see it as future net carbon sink. I think Dr. Fields said the majority of natural land CCS volume is in the fungus etc. biome in the soil. How much added fungus and biome will the future urban canopy add that is not already in the ground in our yards (including the 36 inches between the curb

and the sidewalk)? So, I'm a fan of using the cost of CCS to design the optimal Emission Reduction programs.

- Mayor Burt just referred to biochar and addressed its potential. A helpful, but somewhat dated, introduction to biochar can be found in Professor Johannes Lehmann's presentation at Stanford in 2010, "[Does Biochar Deliver Carbon Negative Energy?](#)". Slide 47, among others, expands on Mayor Burt's comments by describing the fourfold benefits of biochar: "Mitigation of Climate Change/Waste Management/Energy Production/Soil Improvement." The last point, concerning soil improvement, dovetails importantly with Professor Field's comments about global needs to maintain and perhaps increase agricultural productivity, particularly in the current geopolitical environment.
- Carbon pricing, be sure to look at how Sweden set its carbon prices.
- IPCC WG-III's recent report, "[Climate Change 2022, Mitigation of Climate Change](#)" discusses experiences with and means of improving, including the following at TS-111

"Carbon pricing is effective in promoting implementation of low-cost emissions reductions (high confidence). While the coverage of emissions trading and carbon taxes has risen to over 20 percent of global CO₂ emissions, both coverage and price are lower than is needed for deep reductions. Market mechanisms ideally are designed to be effective as well as efficient, balance distributional goals and find social acceptance. Practical experience has driven progress in market mechanism design, especially of emissions trading schemes. Carbon pricing is limited in its effect on adoption of higher-cost mitigation options, and where decisions are often not sensitive to price incentives such as in energy efficiency, urban planning, and infrastructure (robust evidence, medium agreement). Subsidies have been used to improve energy efficiency, encourage the uptake of renewable energy and other sector specific emissions saving options {13.6}

Carbon pricing is most effective if revenues are redistributed or used impartially (high confidence). A carbon levy earmarked for green infrastructures or saliently returned to taxpayers corresponding to widely accepted notions of fairness increases the political acceptability of carbon pricing. {5.6, Box 5.11}"

This work from IPCC WG-III provides additional support for carbon taxes as a mitigation measure and underscores both the need for carbon prices to be set high enough to reach "higher-cost mitigation options" and to use revenues from carbon taxes for redistribution and green infrastructure.

- This spring and summer is a great multi-city collaboration opportunity on efforts for making optimal Reach Codes that make electrification the norm.
- The City should clearly differentiate between its current electric portfolio goal ("carbon neutrality on an annual basis") and a zero-carbon electricity supply on a 24x7 basis in outreach to the public and when quoted by the press. [NOTE: This comment refers to the City's "Carbon Neutral Electric Portfolio" rather than carbon neutrality as used in the February 14 Ad Hoc Committee discussion, which referred to ensuring net zero emissions for a broader set of activities than just electricity generation]